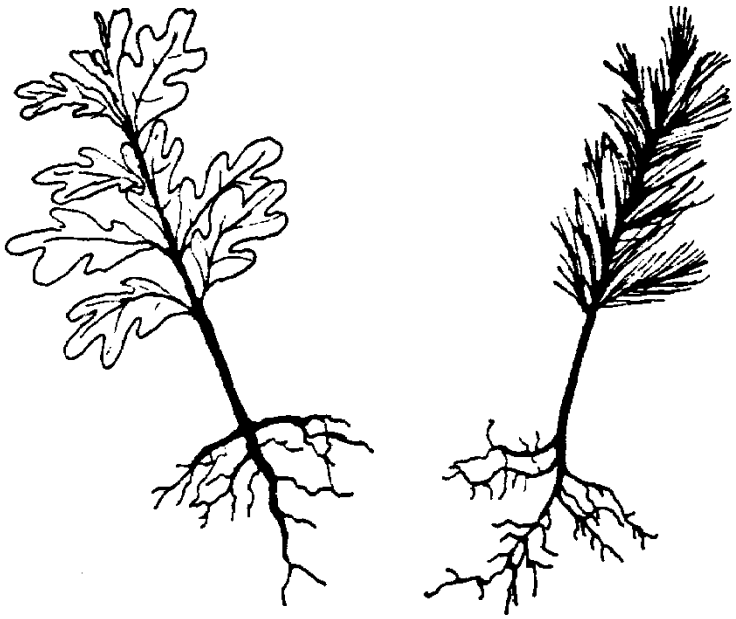
Seedling Care

and

Reforestation Standards



ALABAMA FORESTRY COMMISSION

INTRODUCTION

Quality and successful tree planting does not happen by chance. Success requires thought, planning, and attention to detail. From the first seed planted at the nursery to the last seedling planted in the field, all persons involved must accept responsibility for tree planting success or failure - negative impacts of poor seedling care and handling accumulate and cannot be reversed. Professional planting can be ruined by improper handling before the first seedling is placed in the ground. Likewise, fool-proof care and handling can be ruined by improper planting techniques. In either event, time, effort, and money is wasted.

Seedlina Care and Reforestation Standards is intended to help landowners and vendors achieve quality and successful planting. So doing, newly planted seedlings will be prepared to capitalize on favorable growing conditions and better prepared to deal with growing conditions that are adverse.

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I. Seedling Care and Handling Before Planting

Planting trees that will live starts with transportation and storage of seedtings between the nursery and planting site. Just like apples, oranges, and milk, ***SEEDLINGS ARE PERISHABLE!*** If they are mishandled during transportation and storage, ***THEY WILL SPOIL AND DIE!*** Follow the recommendations below to help insure your seedlings are at their best when planted.

Advice on Transportation

Use refrigerated transportation - especially when transportation will exceed 2-4 hours. Refrigerate at 33-38 F and 85.95% relative humidity.

Do not stack seedlings more than 3 bundles high. Use spacers to provide sufficient air space between stacks of bundles to reduce heat build-up.

Do not transport seedlings in truck beds containing fertilizer, chemicals, or fuel residues. These substances can be lethal to seedlings.

If seedlings must be hauled in open truck beds, use a tarpaulin to cover the seedlings. Leave sufficient air space between the top of the seedlings and the tarpaulin so air can circulate and reduce heat build-up.

Park in the shade when you stop to limit sun exposure on seedlings and reduce the chance of heat build-up.

Unload and properly store seedlings as soon as you reach your destination.

Advice on Storage

Use refrigerated storage, especially for storage in excess of 3-5 days.

> ***store at 33-38 Fand maintain 85-95% humidity***
>
> ***do not stack seedlings more than 2 bundles high and use spacers to provide sufficient air space between, stacks of bundles and reduce heat build-up***
>
> ***for best results, plant as soon as possible within 4 weeks***
>
> ***store no longer than 8- 12 weeks***

From lifting to landowner pick-up, the Alabama Forestry Commission provides refrigerated transportation and storage for all their bareroot seedlings. With cooler facilities at E.A. Hauss Nursery in Atmore, refrigerated vans, and ***local cooler*** facilities et ***various Alabama Forestry Commission District Offices across the state, landowners and tree planting vendors can pick up refrigerated seedlings within a two hour drive from anywhere in Alabama.***

If non-refrigerated storage must be used:

store in a protected area such as a shed to avoid freezing, wind, and heat build-up provided that the area is not prone to overheating during direct sunlight

do not stack seedlings more than two bundles high and use spacers to provide sufficient air space between stacks of bundles to reduce heat build-up

for best results, plant as ***soon as possible***

store no longer than 2-3 weeks if storage temperatures range from 38-5 0 F

Bareroot longleaf pine seedlings do not store as well as other seedlings. Extra effort should be made to arrange for planting to occur within 10 days of lifting at the nursery.

store no longer than 3-5 days if storage temperatures range from 50-70 F

II. Evaluating Seedling Ouality

Seedling quality is determined by two seedling properties: physical features and condition. Evaluating both types of properties are critical to insure quality and successful planting and seedling establishment.

A. Physical Features

Pine Seedlings

Many physical features are used to assess seedling quality, such as stem length, root length, root collar diameter, and lateral root abundance. Unless altered during the handling and/or planting process, these physical features remain the same from the time a seedling is lifted at the nursery until it is planted and begins to grow. For this reason, seedlings should be inspected for acceptable physical features as soon as they are received from the nursery.

Nearly all survival studies show that balanced, medium-sized seedlings (7 to 13 inch stem height) with sturdy stems and well-developed, fibrous root systems have a higher survival rate and make better initial growth than do either larger or smaller seedlings. One of the most important physical features that is vital to seedling survival is the relationship between the size of the root mass and the size of the foliage. Seedlings with far more foliage than roots (top-heavy seedlings) have a transpiring surface out of proportion to the absorbing capacity of the roots. Simply put, the foliage of top-heavy seedlings can transpire water out of the seedling faster than the roots can bring water in to the seedling. As a result, seedlings can out and die.

A quality pine seedling should have a relatively small top and a large fibrous root system.

Table 1 lists the minimum requirements for acceptable pine seedlings. You should evaluate your seedlings before planting. If most of your seedlings meet these requirements, remember to cull inferior seedlings as they are pulled for planting. *If the majority of your seedlings do not meet these minmums, notify the nursery where you obtained your trees- don 't overlook it.*

Table 1. Minimum Quality Measures for Pine Seedlings

Quality Measure	Loblolly Slash Shortleaf	Longleaf
Stem Length	5"	I"(needle length)
Root Collar Diameter	I/8"	318"
Root Length	5"	5"
Literal Roots	Abundant	Abundant
Winter Buds	_____	Present
Mycorrhizae	Present	Present

Hardwood Seedlings

Two primary physical features are used to assess the quality of hardwood seedlings: root collar diameter and stem length. For hardwood seedlings, the following minimum standards should be met:

Root collar diameter - 3/8 inch

Stem length - 18 inches

B. Seedling Condition

Unlike physical features, the condition of both pine and hardwood seedlings can change and change rapidly when seedlings are improperly stored or transported. For this reason, seedlings should be monitored and inspected continuously - from pick-up until they are successfully planted. Indicators of seedling deterioration and unacceptable condition include:

sour smell due to heat build-up and fermentation

yellow needles

seedlings are warm to the touch due to heat build-up

bark slips off easily, especially on the roots

the cambium layer is yellow to brown

seedlings are molded

The cambium is a layer of soft tissue that lies between the bark and the woody portion of the seedling. Healthy cambium is glistening white in color and is a very good indicator of seedling condition. This layer can be inspected by peeling back the bark with your fingernail or a knife blade. If the color of the cambium is yellow or brown, do not plant the seedlings.

III Seedling Care and Handling During Planting

A. On-Site Seedling Storage

When seedlings are taken to the planting site proper care and handling often takes a back seat to the actual planting task. However, this period may present the harshest conditions seedlings will face before being planted.
Take the following precautions to minimize the adverse effects of on-site storage:

Do not carry to the site more seedlings than can be planted in one day.

Stack seedlings in the shade to reduce sun exposure. If natural shade is not available use a tarpaulin to provide shade.

Freezing at 20 F for 6-24 hours slightly lowers the survival of loblolly and slash pine seedlings, and completely kills longleaf pine seedlings.

Cover seedling roots in open bundles and keep them moist.

Avoidexposing seedlings to freezing temperatures. If seedlings freeze allow them to thaw gradually before separating.

Preferred weather conditions for on-site storage are:

- *air temperature of 33 75 F*
- *relative humidity > 50 %*

Plant seedlings as soon as possible.

B. Time of Planting

Planting Season

Planting season for bareroot seedlings is December through March. Containerized seedlings allow for fall planting as well as during the bareroot planting season. For best results, once bareroot seedlings have hardened off in the nursery, they should be planted as early in the planting season as possible (December-January). If at all possible, complete planting by March 15. to avoid the traditional dry weather of late winter and early spring. Survival of seedlings planted after March 15, will depend largely on adequate rainfall. Special care, handling and storage must be used for any planting beyond March 15.

Planting seedlings in the early part of planting season allows time for new root growth during the dormant season. Seedlings with established root growth are better prepared to compete successfully for water and nutrients during the upcoming spring.

Weather Considerations During Planting

Weather conditions at the time of planting can be beneficial or adverse to young seedlings. Cool, moist conditions help minimize seedling exposure during the planting process. High temperatures, low humidity, strong winds, and dry soil conditions can harm seedlings during the planting process, especially when coupled with improper care and handling. To the maximum degree possible, avoid planting when weather conditions are critical, and take special care to protect seedlings from exposure when weather conditions are marginal.

Category	Weather Conditions	
Normal	Temperature:	33 - 75 F
	Relative Humidity:	>50%
	Wind Speed:	<10 mph
	Soil Moisture:	abundant
Marginal	Temperature:	76 - 85 F
	Relative Humidity:	30 - 50%
	Wind Speed:	10 - 15 mph
	Soil Moisture:	marginal
Critical	Temperature:	<32F or >85 F
	Relative Humidity:	<30%
	Wind Speed:	>15 mph
	Soil Moisture:	low to absent

If seedlings must be planted when weather conditions are marginal or critical, take precautions to protect seedlings from potential damage.

Guard your seedlings against damage from:	
High temperatures:	protect seedling bundles from sun exposure and overheating.
Low humidity: High wind:	protect seedlings from drying out.
Low soil moisture:	if at all possible, wait for soil moisture conditions to improve, especially if dry weather patterns are expected to persist.

IV. Proper Planting Techniques

A. Methods of Planting

There are two broad types of tree planting techniques - hand and machine planting. Either method is acceptable and can be performed successfully using a variety of planting tools or equipment when proper techniques are employed. Common examples include:

1. Pine Hand Planting
   Dibble bars - OST, KBC, and containerized
   Hoedads
   Planting shovels

2. Hardwood Hand Planting
   Shovel
   Po wef auger
   Post hole digger
   Hardwood planting dibble

3. Machine Planting
   Continuous furrow planters
   Intermittent planters
   Planting hole wheel
   Specialized container planters

B. Equipment

Proper planting techniques begin with using adequate equipment. Pine seedlings will require a hand planting tool or machine planter that will create a planting slit at least 8 inches deep (10 inches is preferred) and 3 inches wide toaccommodate pine seedling roots and allow proper root alignment. If the equipment being used is not adequate it should be replaced. Most hardwood seedlings have a more massive root systems than pine seedlings and therefore require larger planting holes for proper planting. Hardwood planting tools and machine planters should be capable of making a slit 12-15 inches deep and 4 inches wide to accommodate proper root alignment.

C. Seedling Care and Root Protection

Seedlings should be inspected when the seedling bundles are opened. If the majority of the seedlings do not meet the minimum criteria for acceptable seedlings found in Table 1, the seedlings should not be planted - contact the nursery. Also check seedling condition; do not plant seedlings that show signs of deterioration.

Seedling roots should have been root pruned at the nursery. Tap roots should range from 5-10 inches in length and lateral roots should be abundant. Roots should not be pruned in the field. Both tap- and lateral root alignment will be acceptable if a planting slit of proper depth and width is constructed and proper planting techniques are followed. If a few seedlings have excessively long tap roots that impair proper root alignment, cull those seedlings as they are pulled from the planting bag. If the majority of your seedlings have excessively long (greater than 10 inches) that impair proper planting, contact the nursery where you obtained your seedlings and seek a suitable remedy.

ROOT PROTECTION NOTES

When separating seedlings, do not beat seedlings against objects to loosen the roots.

Do not shake-off or remove moisture retentive root coatings.

Do not root prune seedlings to make them easier to plant.

Protect and keep lateral roots intact - lateral roots are the primary source of water and nutrient uptake.

Seedlings should be carried in seedling bags, buckets, or other suitable containers that will allow the seedlings to be kept moist and protected. Seedlings should not be carried in the tree planters hand with the roots exposed.

D. Culling Seedlings before Planting

If seedlings are not culled when they are taken from the seedling bundles, individual inferior trees should be culled as they are pulled from the planting bag. Cull seedlings which do not meet the minimum criteria listed in Table 1 as well as seedlings with forked tops, evidence of fusiform rust, or other noted undesirable traits.

E. Seedling Placement and Packing

When hand planting, planting slits should be constructed according to Exhibit A in the Appendix. After a proper planting slit is made, insert the seedling until the tap root reaches the bottom of the planting slit, then raise the seedling to the proper planting depth. After the seedling is raised to the proper planting depth and it is in a vertical position without leaning, close the planting slit and pack the soil around the planting hole. Proper packing can be determined for pine by grasping four of the terminal needles. If the seedling moves up when the four needles are pulled, the seedling is improperly packed. If the seedling remains still and the four needles release, packing is suitable.

Proper Planting Depth

For hardwood, and all pines other than longleaf, seedlings should be planted with their root collar 1-2 inches below ground line. Deeper planting may be beneficial on droughty soils such as deep sands and dry ridges. In either situaltion, the terminal bud should be at least 3 inches above ground line.

Longleaf pine is more sensitive to improper planting depth, especially shallow planting. Longleaf seedlings should be planted at a depth that will leave the root collar at or slightly below ground level once the soil around the seedling settles.

V. Minimum Standards for Cost-Share Tree Plantings

The Alabama Forestry Commission (AFC) provides recommendations for forestry practices performed under the state and federal cost-share programs and certifies that practices are correctly implemented. The minimumstandards used when checking cost-share tree plantings serve two primary purposes: 1) To help insure that landowners receive quality tree planting which results in a planted stand with a substantial chance of long term survival and success; and 2) to insure that cost-share funds are used wisely by funding quality and successful tree planting. This section addresses the criteria that AFC personnel use to determine if tree planting practices meet minimum standards.

A. Tree Planting Inspections

After tree planting is completed, the AFC will inspect the planting for the following:

I) Is the number of trees planted per acre within +25%of the number of trees per acre recommended in the treatment plan?

2) Is the number of trees correctly planted per acre 75% or more of the number of trees per acre recommended in the treatment plan?

If the answer to both questions is YES, the tree planting is approved. If the answer to either of these questions in NO, the tree planting will not pass inspection.

B. Defining a "Correctly Planted Seedling"

For AFC inspection purposes, a correctly planted seedling is a seedling that meets the minimum criteria for an acceptable seedling as noted in Table 1, and which is planted in a manner **that reflects** quality planting. The following examples are indicative of seedlings that do not meet "Correctly Planted" criteria.

Cull Seedling	*Seedling does not meet the minimum criteria noted in Table 1, or is deformed, forked, or disease infected.*
Debris in Planting Hole	*Limbs, leaves, and/or other debris are in the planting hole in amounts that create air pockets.*
Improper Depth	*Seedling is planted too deep (terminal bud less than 3" from ground line) or too shallow (root collar above ground line).*
Excessive Lean	*Seedling has top lean in excess of 45 degrees from vertical or tap root lean in excess of 30 degrees from vertical.*
Improper Packing	*A pine seedling that does not pass the "four needle test" or a hardwood seedling that is excessively loose.*
J-rooted Seedling	*Improper root alignment due to a shallow planting hole or improper placement of the seedling when planted.*
L-rooted Seedling	*Improper root alignment within 5" of ground line due to a shallow planting hole, improper placement of the seedling in the hole when planted, or with machine planters due to improper furrow depth and/or excessive tractor speed.*
Twisted or Balled Roots	*Improper root alignment due to root damage during removal from the planting bale, due to field attempts at root pruning, or due to forcing roots into planting holes that are too shallow and/or too narrow.*
Improper Pruning	*Improper root condition due to removal of lateral roots and/or pruning of the tap root to a length less than 6".*
Needle Discoloration	*Evidence of a seedling that is highly likely to die. Causes can include improper transportation, storage, and handling prior to planting, as well as many other causes.*
Dead Seedling	*A seedling that is no longer alive.*

C. Inspection Procedures

Cost-share tree plantings will be inspected by systematically sampling 1/100th acre plots over the planted site. Depending on tract size, the number of plots sampled will be determined by the following:

Field or Tract Size	Minimum #Plots
< 10 acres	3
10-25 acres	5
> 25 acres	1 plot/5 acres (no more than 30)

For each plot, the total number of trees planted will be recorded and used to determine if the number of trees planted par acre is within +25% of the number of trees recommended per acre in the treatment plan. *The number of trees planted per acre* is determined using the following formula:

(# of planted trees on all plots) ÷ (# of plots taken) x 100

Within each plot, detailed observations will be taken on the 5 trees closest to plot center to determine if they are correctly planted. Observations will be made both above and below ground for pine. All trees which appear correctly planted based on above ground observations will be excavated for below ground observation. Trees which are incorrectly 'planted based on above ground observations will not be excavated. For hardwood, only above ground observations will be taken. The status for each of the detailed observation trees will be recorded on the Tree Plantina Inspection Form. The information obtained will be used to determine the percentage of the detailed observation trees which are correctly planted. The percentage of trees correctly planted and the number of trees planted per acre will be used to determine if the number of trees correctly planted per acre is 75% or more of the number of trees per acre recommended in the treatment plan. The *number of trees correctly planted per acre* is determined using the following formula:

(# of correct observations) ÷ (# of observations) x (# of trees planted per acre)

If this number is greater than or equal to 75% of the number of trees recommended per acre in the treatment plan, the tree planting has passed inspection.

If the tree planting does not pass inspection, the landowner has until May 1, immediately following the date of planting to correct problems noted in the inspection and avoid practice disapproval. In the event of a dispute, appeals are to be made to the appropriate AFC District office.

VI. Additional Steps to Insure Successful Planting

The risk of planting failure due to human causes can be significantly reduced by following the guidelines in this handbook. The following considerations should be employed by the landowner and vendor to insure that the chance of tree planting success is maximized.

A. Landowner Considerations

PLAN AHEAD - don't wait until the last minute to perform site preparation, acquire seedlings, and hire a tree planting vendor. You may benefit by hiring someone to handle all the work from start to finish.

If you are planting trees under a cost-share program, make sure you understand the treatment plan prepared by the local AFC office. If you don't understand the plan or would like to do things differently, contact the AFC agent who prepared the plan before proceeding to insure that you will remain eligible for cost-share.

Ask others in your area who have hired tree planting vendors in the past. Use a vendor with a good reputation and that has the ability to transport and store seedlings correctly as outlined in this handbook.

Sign a contract with the vendor that clearly states the following:

- planting equipment must be capable of creating proper planting slits
- seedlings planted must meet the minimum criteria outlined in Table 1
- seedlings must be properly transported, stored and handled at all times
- planting must be performed during suitable weather conditions
- seedlings must be planted correctly as outlined in this handbook
- the date by which planting must be completed
- how many correctly planted seedlings per acre are required to receive payment

Visit the site during the planting operation and inspect the work.

B. Vendor Considerations

Make sure you have proper transportation, storage, and handling abilities before planting season arrives

Make sure planting equipment is suitable.

Train tree planters to transport, handle and plant trees properly

Maximize tree planting during the early part of planting season

Minimize planting during adverse weather conditions, and take special precautions when planting cannot be avoided

Use a crew foreman to insure that trees are properly handled and planted

Exhibit A - Proper Hand Planting Techniques

DIBBLE PLANTING

I) Fully insert dibble straight down into the soil and pull back to open the planting hole.

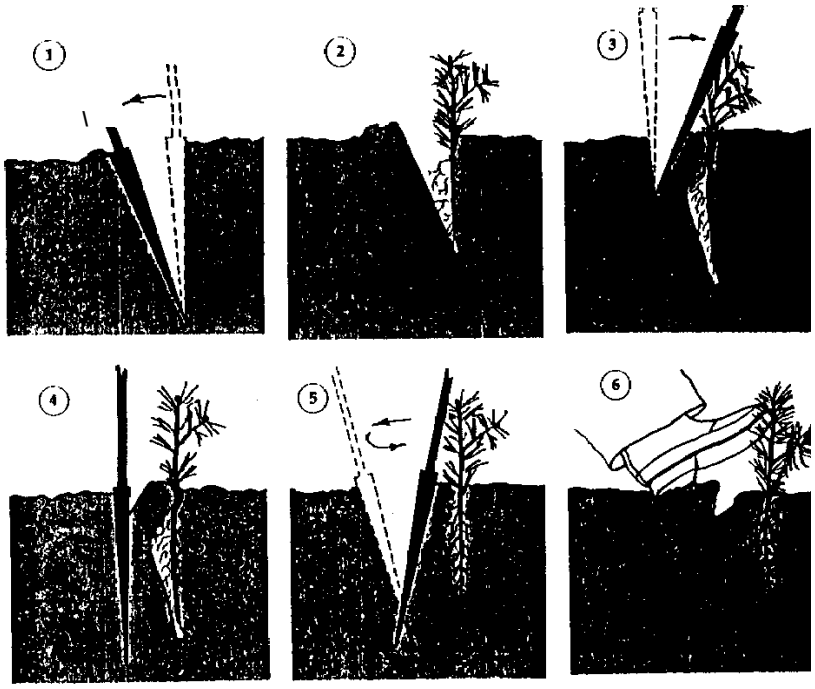
2) Remove dibble, insert seedling roots to the bottom of the planting hole, then raise root collar to the proper depth (I-2" below ground line).

3) Insert dibble halfway, several inches from the base of the seedling. Push handle forward and close top of planting hole.

4) Fully insert dibble several inches down behind the seedling.

5) Pull back handle to close bottom of planting hole. Push handle forward to close the top.

6) Remove dibble and close-up the opening with your heel.



HOEDAD PLANTING

1) Strike blade vertically to full depth in the soil. Pull handle up a few inches to open the bottom of the planting hole.

2) Slide hand down handle, almost to the blade. Pull handle back and down to open the top of the planting hole. Insert seedling roots to the bottom of the planting hole and raise root collar to the proper depth (I-2" below ground line).

3) Hold seedling in place and remove hoedad. Loose soil should fall into the hole and hold the seedling.

4) Insert blade halfway, several inches from seedling, and push soil against the seedling.

5) Use foot to firm the soil against the seedling.

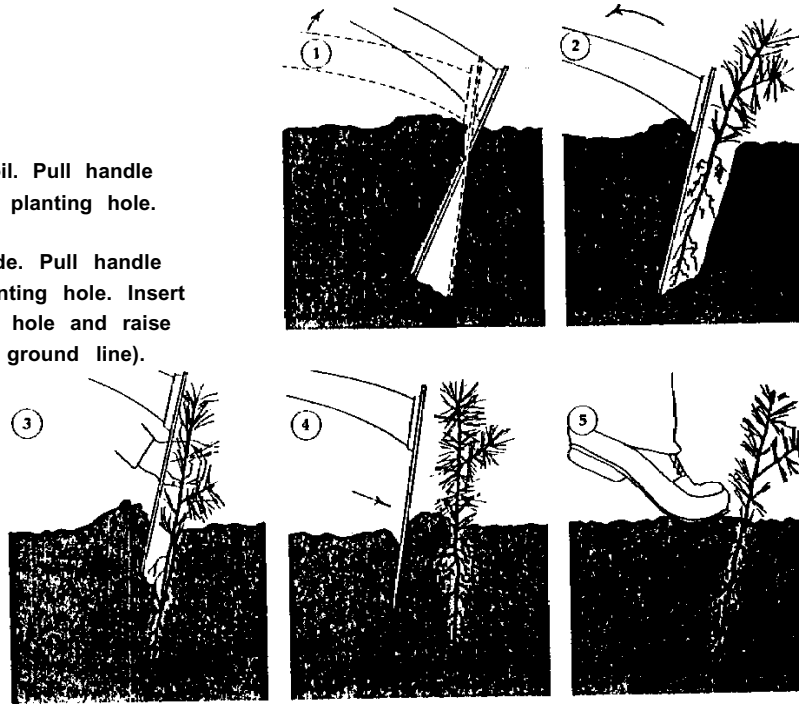
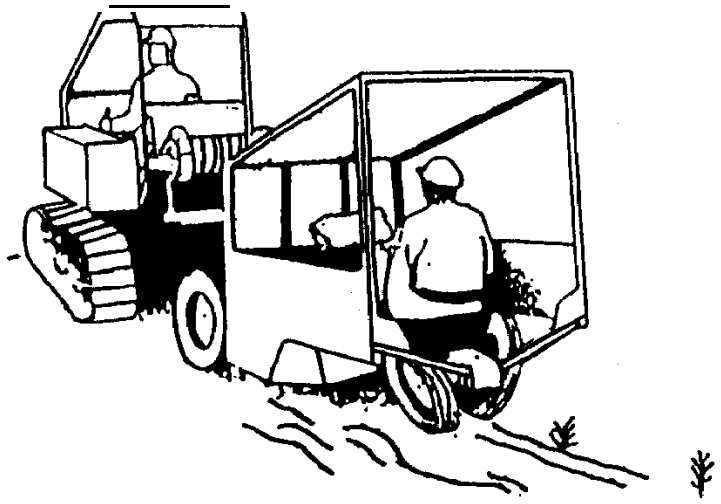


Exhibit B - Machine Planting Notes

For Safety, tractor and tree planting machines should have protective canopies.



OPERATIONAL CONSIDERATIONS

1. **Use equipment with sufficient horsepower to pull mechanized tree planters.**

2. **Drawbar hookup should be no more than 14” from ground line.**

3. **Hitch arms for 3-point hitch planters should be the same length to assure straight planting rows.**

4. **Tractor speed should not exceed 2-2 miles per hour.**

5. **Packing wheels should be adjusted out for sandy soils and angled in for clay soils.**

EXHIBIT C. Four Days in the Life of a Mishandled Seedling.

Event	Elapsed Time	Type Damage	Potential Loss in % Survival	Cumulative Potential Loss in % Survival
LIFTING				
- loss of roots mycorrhizae	2 minutes	Physical	9 %	9 %
- Seedlings placed in tubs, exposed to sur and wind prior to pickup	20 minutes	Dessication	7 %	16%
PACKING				
- Unloading seedlings in packing area and separation	2 minutes	Physical and Dessication	6 %	22%
- Exposure on the grading belt	30 seconds	Dessication	2 %	24%
- Rough handling	30 seconds	Physical	5 %	29%
SHIPPING				
- Bags improperly stacked	2 hours	Physical Overheating	7 %	36%
STORAGE				
- inadequate ventilation	2 days	Overheating	9 %	45%
PLANTING				
- exposure during planting	20 minutes	Dessication	5 %	50%

This chart depicts potential losses in the survivability of a mishandled seedlings. You can minimize these adverse effects by providing proper care and handling for your seedlings throughout the entire tree planting process.

For information on cooler locations
contact Hauss Nursery at 1-251-368-4854